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RACE AND OUTCOMES IN GASTROSCHISIS REPAIR: A NATIONWIDE ANALYSIS

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Abstract

Background: The incidence of gastroschisis has increased 30% between the periods 1995–2005 and 2006–2012, with the largest increase in Black neonates born to Black mothers younger than 20 years old.

Objective: Racial disparities in peri- and post-operative outcomes have been previously identified in several types of adult and pediatric surgical patients. Is there an association between race and clinical outcomes and healthcare resource utilization in neonates with gastroschisis?

Methods: Retrospective study using national administrative data from the Kid's Inpatient Database (KID) from 2006, 2009, and 2012 for neonates (age <28 days) with gastroschisis. Multivariable logistic regression was constructed to determine the association of race and socioeconomic characteristics with complications and mortality; linear regression was used for length of stay and hospital charges.

Results: We identified 3846 neonates with gastroschisis that underwent surgical repair, including 676 patients with complex gastroschisis. When controlling for birth weight, payer status, socioeconomic status, and hospital characteristics, Black neonates had increased odds of having complex gastroschisis and associated atresias. Mortality was higher in patients with complex gastroschisis, patients from the lowest income quartiles, and patients with Medicaid as primary payer (compared to those with private insurance). Length of stay (LOS) was increased in patients with complex gastroschisis, birth weight <2500 g, and Medicaid patients. Hospital charges were higher in complex gastroschisis, Black and Hispanic neonates (as compared to Whites), males, birth weight <2500 g, and Medicaid patients.

Conclusions: There is an association between race and complex gastroschisis, associated intestinal atresias, and total charges in neonates with gastroschisis. In addition, income status is associated with mortality and hospital charges while payer status is associated with complications,

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mortality, LOS, and hospital charges. Public health and prenatal interventions should target at-risk populations to improve clinical outcomes.

Prognosis Study: Level of Evidence: II

Keywords

Gastroschisis; Pediatric Surgery; Outcomes; Race; Health Disparities

Gastroschisis is a congenital abdominal wall defect through which intraabdominal viscera protrude [1]. The medical and post-surgical management of neonates with gastroschisis varies considerably [2], however, surgical repair of the abdominal wall defect is common [3]. Complex gastroschisis (10.9% of gastroschisis cases) [4] defined as the presence of atresia, volvulus, necrotic bowel, or bowel perforation, is as-sociated with delayed implementation of enteral feedings and achievement of full feeds, higher complication rates, an increased length of stay, and increased mortality [4–6]. Survival rates are as high as 90–97%, however; the repair of complex gastroschisis is associated with a high risk of short- and long-term morbidity [5]. Other factors that increase the risk for mortality in gastroschisis include large bowel resection, congenital circulatory and pulmonary disease, and sepsis. Contributing risk factors for sepsis include intestinal ostomy, congenital circulatory anomalies, and necrotizing enterocolitis [6].

Several studies have attempted to identify prenatal and perinatal factors that can predict poor outcomes in gastroschisis. Polyhydramnios [5], low birth weight, and prematurity [7] are associated with worse outcomes (i.e., prolonged time to full enteral feeds, increased length of hospital stay [LOS], higher rates of sepsis). Clear association has not been demonstrated for other factors, such as mode of delivery, surgical technique used for repair, bowel dilation and bowel wall thickness [2,8].

The Institute of Medicine report in 2003 identified the study of health disparities in the United States as one of the most important public health issues; these health disparities still persist today--racial and ethnic minorities receive suboptimal healthcare, regardless of access-related factors [9]. A growing body of evidence suggests that patient demographic factors, such as race, socioeconomic status, and payer status are associated with health disparities in peri- and post-operative outcomes in pediatric surgery, including general, cardiac, neurological, and oncologic procedures [8,10–13]. In addition, risk-adjusted analysis of race and gender by Stone et al. revealed significant differences in postoperative morbidity, mortality, and hospital resource utilization for pediatric surgeries [14].

Gastroschisis disproportionally affects young mothers. Furthermore, the incidence of gastroschisis has increased 30% between the two periods 1995–2005 and 2006–2012, with the largest increase in Black mothers younger than 20 years old [15].

The treatment and management of patients with gastroschisis utilizes a significant amount of healthcare resources [6]. For patients with uncomplicated gastroschisis, the median length of stay is 28 days and median hospital charges are $90,788. Moreover, complex gastroschisis increases the median LOS (67 days), median inflation adjusted hospital charges ($197,871), and the risk of complications (gastrointestinal, respiratory, or infectious) (2.9% vs. 8.7%) [4]. The aim of this study was to identify whether a patient's race was associated with adverse clinical outcomes and increased healthcare resource utilization in neonates with gastroschisis.

1. Patients and methods

1.1. Study design and data source

A retrospective cross-sectional study was conducted using national administrative data from 2006, 2009, and 2012 Kid Inpatient Database (KID) files, the most recently available data sets, produced by the Agency for Healthcare Research and Quality as a component of the Healthcare Cost and Utilization Project (HCUP). This database, released every three years, contains demographic, clinical, and charge data for all pediatric inpatient encounters from community, non-rehabilitation hospitals in the United States. A total of 38 to 44 states participated from 2006 to 2012, and approximately 4000 hospitals reported in 2012. Information in the KID includes but is not limited to: age at admission, sex, race, payer status, median zip code income, diagnosis and procedure codes, total hospital charges, length of stay, and hospital characteristics such as size, location, and teaching status.

1.2. Study cohort

Neonates (<28 days of age) with gastroschisis were identified by International Classification of Diseases, Ninth Revision (ICD-9) procedure code of 54.71 [16].

1.3. Predictor variables

Predictor variables were race, socioeconomic status, payer status, and birth weight. Gender, hospital region, bed size, ownership, and teaching status were included in the regression model to control for possible confounding characteristics. Race was defined as White, Black, Hispanic, or Other, as reported by the KID. The median household income of the patient's home zip code served as a proxy for socioeconomic status and was defined by quartiles (For 2012: quartile 1: $1 to $38,999, quartile 2: $39,000 to $47,999, quartile 3: $48,000 to $62,999, quartile 4: N$63,000), derived from ZIP Code-demographic data obtained from Claritas. Payer status was defined as Medicaid, Private, or Other (self-pay, charity, uninsured). Birth weight was defined as <1500 g, 1500 to 2499 g, and ≥2500 g, as a proxy for gestational age at birth (a variable found to be unreliably reported in the KID data as ICD-9 diagnostic codes for prematurity) [17,18]. Birth weight of <1500 g was used as a proxy for prematurity. Hospital regions were defined as northwest, mid-west, south and west. Hospital bed sizes were defined as small or large, as defined by the HCUP-KID. Hospital ownership was defined as either government (public) or private.

1.4. Outcomes

In-hospital complications, mortality, LOS, and total hospital charges were the primary outcome measures in neonates with gastroschisis. In-hospital complications related to complex GS, such as atresia, volvulus, necrotic bowel, or bowel perforation (indicated by additional abdominal surgery) were identified in the patient dataset by searching for pertinent ICD-9 diagnostic and procedure codes, which may have been entered into the patient's chart at any point in the hospitalization. In-hospital mortality, LOS and total hospital charges were already present in the administrative data. Total hospital charges were calculated with the HCUP-KID cost to charge ratio file and then inflation adjusted to 2012 dollars. All charges were converted to 2012 dollar amounts using the consumer price index.

1.5. Statistical analysis

All statistical analyses were adjusted for the KID survey design and discharge weights were used in the analysis to generalize results at the national level. Descriptive statistics were used to characterize the study cohort. In-hospital complications and mortality were summarized using proportions; LOS and total charges were described using medians and interquartile ranges (IQRs). Unadjusted categorical and continuous variables were compared by patient characteristics using chi-square and t-tests, respectively. Multivariable logistic regression was constructed to determine the association of race with in-hospital complications and mortality. Multivariable linear regression was used to determine association of predictor variables with LOS and total hospital charges. All statistical analyses were performed using SAS 9.4 (SAS Institute Inc., Cary, North Carolina). This study was considered non-human subjects research and was deemed exempt by the Institutional Review Board at the University of Texas Medical Branch, Galveston.

2. Results

Out of 12,485,585 weighted neonatal discharges, we identified 3846 (0.03%) neonates with gastroschisis who underwent repair with birth weights available. Demographic characteristics are described in Table 1. Overall, in-hospital mortality was 3.7%, median LOS was 35.3 days (IQR: 24.8 to 58.5) and median total hospital charges were $218,933 (IQR: $139,717 to $384,184). For patients with simple gastroschisis, in-hospital mortality was 1.97%, median LOS was 32.6 days (IQR: 24.0 to 47.2) and median total hospital charges were $196,148 (IQR: $133,913 to $322,671).

We identified 676 (17.6%) neonates with complex gastroschisis, which was defined as presence of atresia, volvulus, necrotic bowel, or bowel perforation (indicated by additional abdominal surgery during that hospitalization). For patients with complex gastroschisis, in-hospital mortality was 11.7%, median LOS was 76.6 (IQR: 42.1 to 119.2) and median total hospital charges were $406,434 (IQR: $233,102 to $687,282). There was a significant difference in race, infant birth weight, and hospital ownership for the outcome of complex gastroschisis. Only infant birth weight was significant for the outcome of in-hospital mortality.

Table 2 reports the number of patients with complex gastroschisis, as identified by atresia, volvulus, necrotic bowel, or bowel perforation (indicated by additional abdominal surgery during that hospitalization) and corresponding odds ratios for the aforementioned complications. Black neonates had an increased odds ratio of 1.744 (1.070–2.843) for atresia. Table 3 reports the association of predictor variables with outcomes. Black race (OR: 1.56, $p < 0.05$), birth weight < 1500 g (OR: 4.62, $p < 0.01$), and government hospitals (OR: 2.03, $p < 0.05$) were independently associated with increased odds of complex gastroschisis, while Medicaid (OR =0.77, $p < 0.05$) and Other race (OR: 0.70, $p < 0.05$) were protective predictor variables.

In Table 3, we report the independent association of predictor variables with complex gastroschisis, in hospital mortality, length of stay, and total hospital charges. Black race was associated with increased odds of complex gastroschisis (OR: 1.56, $p < 0.05$) and increased total hospital charges ($50,495, $p < 0.01$) compared to White neonates. Hispanic race was associated with increased total charges ($69,936, $p < 0.01$) compared to White neonates. Other race was associated with decreased odds of complicated gastroschisis (OR: 0.70, $p < 0.05$) compared to White neonates.

Small for gestational age neonates (birth weight < 1500 g) had increased odds of complex gastroschisis (OR: 4.62, CI: 3.10–6.90, $p < 0.01$), in hospital mortality (OR: 16.1, CI: 7.35–35.3, $p < 0.01$), increased length of stay (+11.9 days, $p < 0.01$), and increased total charges (+$105,275, $p < 0.01$) compared to neonates who weighed ≥2500 g at birth. Neonates who weighed 1500 to 2499 g had increased odds of in hospital mortality (OR: 3.12, CI: 1.57–6.20, $p < 0.01$), increased length of stay (+3.98 days, $p < 0.01$), and increased total hospital charges (+$23,257, $p < 0.01$) compared to neonates who weighed ≥2500 g at birth.

The first income quartile had increased odds of mortality (OR: 2.52, CI: 1.03–6.16, $p < 0.05$) and decreased total hospital charges (−$57,649, $p < 0.01$). The second income quartile also had increased odds of mortality (OR: 1.36, CI: 1.36–8.23, $p < 0.01$) and decreased hospital charges (−$55,407, $p < 0.01$). The third income quartile had only decreased hospital charges (−$53,856, $p < 0.01$) compared to neonates of the wealthiest income quartile. In addition, patients with Medicaid were less likely to have complex gastroschisis (OR: 0.77, CI: 0.60–0.99, $p < 0.05$) and in hospital mortality (OR: 0.56, CI: 0.33–0.97, $p < 0.05$) but had an increased length of stay (+5.12 days, $p < 0.01$) and increased hospital charges (+$23,842, $p < 0.01$).

3. Discussion

Recent pediatric surgical literature has identified racial disparities in pediatric surgical outcomes, even after controlling for established patient- and hospital-related factors [14]. Stone et al., when evaluating postoperative morbidity, mortality, and resource utilization in several pediatric surgeries (appendectomy, pyloromyotomy, intussusception, decortication, congenital diaphragmatic hernia repair, and colonic re-section for Hirschsprung's disease) identified risk-adjusted associations of race with poorer outcomes and higher resource utilization. Black patients are at higher risk for postoperative mortality, and Black and Hispanic patients have increased morbidity and hospital costs. Health disparities are the result of complex, multilevel, dynamic factors, including biological, environmental, and social elements. Prior studies have identified physician–patient communication, provider bias, resource allocation, access to prenatal care, access to specialized care and birth at a pediatric hospital as influencing factors in pediatric surgical outcomes [19–22]. Further complicating the exact cause of healthcare disparities in gastroschisis are variabilities in surgical repair method, ventilation and paralysis strategies, pain management, antibiotic and central line duration, feeding regimens [23], and management of complications such as intestinal perforation and NEC [24].

In our study, after controlling for factors such as gender, prematurity, socioeconomic status, payer status, and hospital characteristics, we observed important racial disparities in peri- and post-operative outcome measures in neonates with gastroschisis. We identified 3846 patients with gastroschisis who underwent repair, representing an incidence rate of 0.03%. The overall in-hospital complication rate was 38%, in-hospital mortality was 3.7%, median LOS was 35 days and median total hospital charges were $218,933 (IQR: $139,717 to $384,184) which is consistent with previously published literature on gastroschisis outcomes [5].

This study further supports the consideration of race and socioeconomic factors as covariates in constructing risk stratification criteria and in healthcare policies [11,18,22,24,25]. Earlier gestational age has been identified as a factor associated with adverse gastroschisis outcomes (death, reoperation, gastrostomy, and NEC) [18]. Prematurity and low birth weight, are known predictors of poor outcomes for surgical and non-surgical neonatal conditions [26]. Our findings--increased morbidity, mortality, length of stay and total hospital charges--are consistent with previously published studies that found prematurity is associated with complex gastroschisis [7]. However, when controlling for low birth weight, Black neonates had increased odds of atresia and complex gastroschisis. When we also controlled for complex gastroschisis, Black neonates had increased total charges compared to White neonates. Intestinal atresia is known to be increased in the African-American population, irrespective of whether they have gastroschisis or not [20,27]. This may be related to genetic susceptibilities, to cultural or social differences that may affect exposures, or a com-bination of susceptibilities and exposures [20]. Hispanic patients also accrued increased additional hospital charges, while patients of other races had a decreased risk of complex gastroschisis compared to White neonates.

Previous studies have demonstrated that Black race is associated with differences in biomarkers of chronic stress (elevated C-reactive protein, adrenocorticotropic hormone (ACTH) [21]. Furthermore, recent research in embodiment theory showed that when pregnant women experience stress, the brain and placenta secrete corticotropin-releasing hormone, which passes into the fetal circulation and affects the fetal neuroendocrine and hypothalamic–pituitary–adrenal axis development. Chronic stressors increase allostatic load--the insufficient termination of the cortisol response system [22]. New research suggests that the allostatic load experienced from chronic stressors affects not only potential mothers, but their children through epigenetic changes, perpetuating health inequalities [25]. Increased stress has been associated with increased risk for spontaneous abortion, preterm labor, and malformations or growth retardations in the fetus [24]. It may be the case that increased allostatic load contributes to the increased association of intestinal atresia and complex gastroschisis in Black neonates. Additional studies need to be conducted in order to elucidate the independent association of race with complex gastroschisis and total charges. The database used in this study does not provide specific enough information on the patient’s clinical course and requires investigation on an institutional level.

Our multivariable regression models also revealed differences between other socioeconomic and hospital demographic groups after adjusting for race and complex gastroschisis. Lowest (1st and 2nd income) quartile patients were independently associated with increased mortality, while simultaneously accruing decreased total charges compared to patients from the 4th (highest) income quartile. While it is plausible that patients from lower socioeconomic statuses die earlier, and thus, accrue fewer charges, there was also no difference in length of stay for patients from the 1st and 2nd quartile. Medicaid insurance status is independently associated with increased mortality, LOS, and higher hospital charges. There were also increased odds of complex gastroschisis for government hospitals, and significant regional differences in total charges. Our data suggest that social factors (more than biologic determinants) associated with low socioeconomic status and primary payer type, such as a lack of or inadequate prenatal care, may contribute to the poorer outcomes observed in these groups. However, because of the limitations of our study, we cannot confirm this hypothesis.

Our study is limited by the use of an administrative database, which relies on accurate and consistent data entry. The use of ICD-9 codes has been validated in identifying patients with gastroschisis; however, it has not been validated for the extensive list of complications and procedures that we examined. The database also does not contain data elements for neonatal gestational age at birth, which is associated with outcomes in gastroschisis [18], or maternal elements (such as pre-natal surveillance and when gastroschisis was identified). The non-specificity of ICD-9 Procedure Codes precludes the authors' ability to account for mode of closure – primary or delayed closure) and number of days from birth until closure in our analysis, which may be a contributing factor to clinical outcomes as infants who underwent a delayed closure may have more severely affected bowel. In addition, the stratification by income level of our sample showed clustering in the low-income quartiles; although this might be a fair representation of the socioeconomic characteristics of the patients with gastroschisis, our analysis using income level as a predictor variable must be interpreted with caution. Despite these limitations, the usage of a national administrative database is essential in identifying associations that may be used to guide additional research questions.

4. Conclusion

There is an independent association of race with complications and total charges in neonates with gastroschisis; intestinal atresia associated with gastroschisis and complex gastroschisis were found to be more common among Black infants, independent of clinically important factors, such as prematurity. Understanding differences in racial and socioeconomic disparities is important to clinicians. Social factors such as lifelong exposure to neighborhood poverty, interpersonal racial dis-crimination, and job strain affect not only birth outcomes such as low birth weight, but also surgical outcomes in gastroschisis. Our data strongly support consideration of race in risk stratification criteria, outcomes research, and healthcare reform efforts. Although different race implies different baseline risk factors determined by genetic factors and distinct exposures, we must remain vigilant to ensure that elements at the provider and system level, such as implicit bias toward the mothers of Black and Hispanic neonates or delayed care, do not increase the odds of poor outcomes in pediatric populations at risk.

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Abbreviations:

KID	Kid's Inpatient Database
ICD-9	International Classification of Diseases, Ninth Revision
IQR	interquartile ranges
LOS	length of stay
OR	odds ratio
SE	Standard error
NEC	necrotizing enterocolitis

References

[1]. Ledbetter DJ. Gastroschisis and omphalocele. Surg Clin North Am 2006;86:249–60. 10.1016/j.suc.2005.12.003 [vii]. [PubMed: 16580922]

[2]. Davis RP, Treadwell MC, Drongowski RA, et al. Risk stratification in gastroschisis: can prenatal evaluation or early postnatal factors predict outcome? Pediatr Surg Int 2009;25:319–25. 10.1007/s00383-009-2342-x. [PubMed: 19277683]

[3]. Allin BSR, Tse WHW, Marven S, et al. Challenges of improving the evidence base in smaller surgical specialties, as highlighted by a systematic review of gastroschisis management. PLoS One 2015;10:e0116908 10.1371/journal.pone.0116908. [PubMed: 25621838]

[4]. Arnold MA, Chang DC, Nabaweesi R, et al. Risk stratification of 4344 patients with gastroschisis into simple and complex categories. J Pediatr Surg 2007;42:1520–5. 10.1016/j.jpedsurg.2007.04.032. [PubMed: 17848242]

[5]. D'Antonio F, Virgone C, Rizzo G, et al. Prenatal risk factors and outcomes in gastroschisis: a meta-analysis. Pediatrics 2015;136:e159–69. 10.1542/peds.2015-0017. [PubMed: 26122809]

[6]. Lao OB, Larison C, Garrison MM, et al. Outcomes in neonates with gastroschisis in U.S. children's hospitals. Am J Perinatol 2010;27:97–101. 10.1055/s-0029-1241729. [PubMed: 19866404]

[7]. Carnaghan H, Baud D, Lapidus-Krol E, et al. Effect of gestational age at birth on neonatal outcomes in gastroschisis. J Pediatr Surg 2016;51(5):734–8. [PubMed: 26932253]

[8]. Austin MT, Nguyen H, Eberth JM, et al. Health disparities are important determinants of outcome for children with solid tumor malignancies. J Pediatr Surg 2015;50: 161–6. 10.1016/j.jpedsurg.2014.10.037. [PubMed: 25598116]

[9]. Smedley B, Stith A, Nelson A. Unequal treatment: confronting racial and ethnic disparities in health care - PubMed - NCBI Inst Med Washington, DC: Natl Acad Press; 2003[http://www.ncbi.nlm.nih.gov/pubmed/25032386 erişim 07 Aralık 2015].

[10]. Patzer RE, Mohan S, Kutner N, et al. Racial and ethnic disparities in pediatric renal allograft survival in the United States. Kidney Int 2015;87:584–92. 10.1038/ki.2014.345. [PubMed: 25337773]

[11]. Shweikeh F, Al-Khouja L, Nuño M, et al. Disparities in clinical and economic outcomes in children and adolescents following surgery for tethered cord syndrome in the United States. J Neurosurg Pediatr 2015;15:427–33. 10.3171/2014.9.PEDS14241. [PubMed: 25559922]

[12]. Chan T, Lion KC, Mangione-Smith R. Racial disparities in failure-to-rescue among children undergoing congenital heart surgery. J Pediatr 2015;166 10.1016/j.jpeds.2014.11.020 [812–8-4].

[13]. Attenello FJ, Ng A, Wen T, et al. Racial and socioeconomic disparities in outcomes following pediatric cerebrospinal fluid shunt procedures. J Neurosurg Pediatr 2015;15: 560–6. 10.3171/2014.11.PEDS14451. [PubMed: 25791773]

[14]. Stone ML, Lapar DJ, Kane BJ, et al. The effect of race and gender on pediatric surgical outcomes within the United States. J Pediatr Surg 2013;48:1650–6. 10.1016/j.jpedsurg.2013.01.043. [PubMed: 23932602]

[15]. Jones AM, Isenburg J, Salemi JL, et al. Increasing Prevalence of Gastroschisis - 14 States, 1995–2012. MMWR Morb Mortal Wkly Rep 2016;65:23–6. 10.15585/mmwr.mm6502a2. [PubMed: 26796490]

[16]. Williams CA, Hauser KW, Correia JA, et al. Ascertainment of gastroschisis using the ICD-9-CM surgical procedure code. Birth Defects Res A Clin Mol Teratol 2005;73: 646–8. 10.1002/bdra.20205. [PubMed: 16240375]

[17]. Rao SC, Basani L, Simmer K, et al. Peritoneal drainage versus laparotomy as initial surgical treatment for perforated necrotizing enterocolitis or spontaneous intestinal perforation in preterm low birth weight infants. Cochrane Database Syst Rev 2011: CD006182 10.1002/14651858.CD006182.pub2. [PubMed: 21678354]

[18]. Overcash RT, DeUgarte DA, Stephenson ML, et al. Factors associated with gastroschisis outcomes. Obstet Gynecol 2014;124:551–7. 10.1097/AOG.0000000000000425. [PubMed: 25162255]

[19]. Choo S, Papandria D, Zhang Y, et al. Outcomes analysis after percutaneous abdominal drainage and exploratory laparotomy for necrotizing enterocolitis in 4,657 infants. Pediatr Surg Int 2011;27:747–53. 10.1007/s00383-011-2878-4. [PubMed: 21400031]

[20]. Egbe A, Lee S, Ho DUS. Effect of race on the prevalence of congenital malformations among newborns in the United States. - PubMed - NCBI. Ethn Dis 2015;25:226–31. [PubMed: 26118153]

[21]. Borders AEB, Wolfe K, Qadir S, et al. Racial/Ethnic differences in self-reported and biologic measures of chronic stress in pregnancy. J Perinatol 2015;35:580–4. 10.1038/jp.2015.18. [PubMed: 25789817]

[22]. Lu MC, Halfon N. Racial and ethnic disparities in birth outcomes: a life-course perspective. Matern Child Health J 2003;7:13–30. 10.1023/A:1022537516969. [PubMed: 12710797]

[23]. Lusk LA, Brown EG, Overcash RT, et al. Multiinstitutional practice patterns and outcomes in uncomplicated gastroschisis: a report from the University of California Fetal Consortium (UCfC). J Pediatr Surg 2014;49:1782–6. 10.1016/j.jpedsurg.2014.09.018. [PubMed: 25487483]

[24]. Mulder EJ, Robles de Medina P, Huizink A, et al. Prenatal maternal stress: effects on pregnancy and the (unborn) child. Early Hum Dev 2002;70:3–14. 10.1016/S0378-3782(02)00075-0. [PubMed: 12441200]

[25]. Collins JW, David RJ. Racial disparity in low birth weight and infant mortality. Clin Perinatol 2009;36:63–73. 10.1016/j.clp.2008.09.004. [PubMed: 19161865]

[26]. Lillehei CW, Gauvreau K, Jenkins KJ. Risk adjustment for neonatal surgery: a method for comparison of in-hospital mortality. Pediatrics 2012;130:e568–74. 10.1542/peds.2011-3647. [PubMed: 22926171]

[27]. Harris J, Kallen B, Robert E. Descriptive epidemiology of alimentary tract atresia. Teratology 1995;52:15–29. 10.1002/tera.1420520104. [PubMed: 8533109]

Table 1.

Demographic characteristics of neonates with gastroschisis.

Characteristics	All Patients [n, (%)]	Complex Gastroschisis [n, (%)]	Mortality [n, (%)]
Sex		p = 0.27	p = 0.54
Male	1970 (51.2)	363 (53.7)	68 (48.0)
Female	1875 (48.8)	313 (46.3)	74 (52.0)
Race		p = 0.001 **	p = 0.18
White	1693 (44.0)	315 (46.7)	66 (46.4)
Black	293 (7.6)	78 (11.5)	19 (13.1)
Hispanic	884 (23.0)	143 (21.1)	28 (20.1)
Other	975 (25.4)	139 (20.7)	29 (20.4)
Birthweight		p <0.001 **	p <0.001 **
<1500 g	215 (5.6)	95 (14.0)	31 (31.7)
1500-2499 g	2421 (63.0)	402 (59.5)	56 (58.6)
≥ 2500 g	1210 (31.5)	179 (26.5)	10 (9.8)
Median zip code income quartile		p = 0.88	p = 0.11
1	1326 (34.5)	230 (34.0)	52 (36.9)
2	1139 (29.6)	210 (31.1)	53 (37.7)
3	890 (23.1)	152 (22.5)	26 (18.4)
4	491 (12.8)	152 (22.4)	10 (6.9)
Primary payer		p = 0.40	p = 0.08
Medicaid	2772 (72.1)	472 (69.9)	89 (62.5)
Private	286 (7.4)	28 (7.1)	37 (26.0)
Other	788 (20.5)	155 (23.0)	16 (11.5)
Geographic region		p = 0.39	p = 0.82
Northwest	415 (10.8)	77 (11.4)	13 (9.2)
Midwest	865 (22.5)	172 (25.5)	29 (20.7)
South	1550 (40.30	260 (38.6)	64 (45.3)
West	1015 (26.4)	165 (24.5)	35 (24.8)
Hospital teaching status		p = 0.21	p = 0.59
Teaching	3376 (87.8)	581 (86.1)	122 (85.9)
Non-teaching	470 (12.2)	94 (13.9)	20 (14.1)
Hospital ownership		p = 0.0005 **	p = 0.47
Government	215 (5.6)	60 (8.8)	10 (7.3)
Private	3631 (94.4)	616 (91.2)	131 (92.7)
Hospital bed size		p = 0.50	p = 0.17
Small	1058 (27.5)	176 (26.0)	50 (23.2)
Large	2787 (72.5)	500 (74.0)	166 (76.8)

** = p <0.01

Table 2.

Association of race with complications and additional procedures in neonates gastroschisis.

Complications	Cases [n (%)]	Odds ratios (95% CI) compared to White neonates		
		Black	**Hispanic**	**Other**
Necrotizing enterocolitis	261 (6.78)	1.284 (0.748–2.205)	0.673 (0.419–1.080)	0.715 (0.484–1.055)
Atresia	312 (8.11)	1.744 (1.070–2.843) *	1.001 (0.685–1.463)	0.830 (0.551–1.249)
Perforation	23 (0.59)	0.826 (0.217–3.146)	0.221 (0.032–1.517)	0.461 (0.122–1.735)
Volvulus	≤ 10	-	-	-
Exploratory laparotomy	122 (3.16)	1.439 (0.688–3.007)	0.667 (0.317–1.404)	0.753 (0.418–1.356)
Colostomy	82 (2.13)	1.908 (0.852–4.270)	1.446 (0.759–2.755)	0.701 (0.315–.559)
Ileostomy	122 (3.16)	0.875 (0.342–2.239)	1.094 (0.609–1.966)	1.048 (0.615–1.785)
Small bowel resection	31 (0.81)	0.684 (0.91–5.142)	1.051 (0.390–2.831)	0.678 (0.214–2.145)

* = $p < 0.05$

Table 3.

Multivariable regression analysis: association of predictor variables with outcomes.

Characteristics	Complex Gastroschisis OR (95% CI)	Mortality OR (95% CI)	Length of Stay β (SE)	Total Charges β (SE)
Race				
Black	1.56 (1.06–2.30) *	1.18 (0.59–2.35)	5.02 (3.40)	50,495 (17,833) **
Hispanic	0.92 (0.69–1.22)	0.80 (0.43–1.48)	1.92 (1.78)	69,936 (11,901) **
Other	0.70 (0.53–0.92) *	0.76 (0.41–1.39)	−0.30 (1.78)	−2350 (8486)
White	-	-	–	-
Sex				
Male	1.17 (0.93–1.46)	0.87 (0.55–1.37)	−2.52 (1.46)	−16,979 (7281) *
Female	-	-	-	-
Birthweight				
<1500 g	4.62 (3.10–6.90) **	16.1 (7.35–35.3) **	11.9 (4.07) **	105,278 (17,948) **
1500–2499 g	1.17 (0.92–1.48)	3.12 (1.57–6.20) **	3.98 (1.42) **	23,257 (8109) **
≥ 2500 g	-	-	-	-
Median zip code income quartile				
1	1.05 (0.75–1.47)	2.52 (1.03–6.16) *	0.48 (2.50)	−57,649 (18,336) **
2	1.18 (0.87–1.60)	3.34 (1.36–8.23) **	0.69 (2.46)	−55,407 (18,466) **
3	1.07 (0.76–1.51)	1.94 (0.76–4.97)	−0.19 (2.52)	−53,856 (17,208) **
4	-	-	-	-
Primary payer				
Medicaid	0.77 (0.60–0.99) *	0.56 (0.33–0.97) *	5.12 (1.89) **	23,842 (10,531) **
Other	0.83 (0.52–1.32)	1.42 (0.66–3.07)	−1.37 (3.06)	9367 (15,044)
Private	-	-	-	-
Geographic region				
Midwest	1.18 (0.80–1.74)	0.92 (0.37–2.31)	−3.58 (3.09)	51,552 (19,756) **
South	0.83 (0.59–1.18)	1.26 (0.54–2.93)	−1.83 (3.42)	−25,712 (20,984)
West	0.89 (0.60–1.32)	1.11 (0.45–2.76)	−2.76 (3.05)	−65,743 (21,896) **
Northwest	-	-	-	-
Hospital teaching status				
Non-teaching	1.21 (0.90–1.63)	1.01 (0.57–1.81)	3.99 (2.80)	43,095 (22,119)
Teaching	-	-	-	-
Hospital bed size				
Small	0.93 (0.71–1.23)	0.80 (0.45–1.41)	0.69 (1.88)	17,661 (9708)
Large	-	-	-	-
Hospital ownership				
Government	2.03 (1.39–2.97) **	0.96 (0.41–2.23)	−2.65 (3.96)	−13,253 (24,997)
Private	-	-	-	-
Complex gastroschisis	-	4.93 (3.10–7.84) **	45.1 (3.05) **	252,286 (14,473) **

* = p <0.05

** = p <0.01